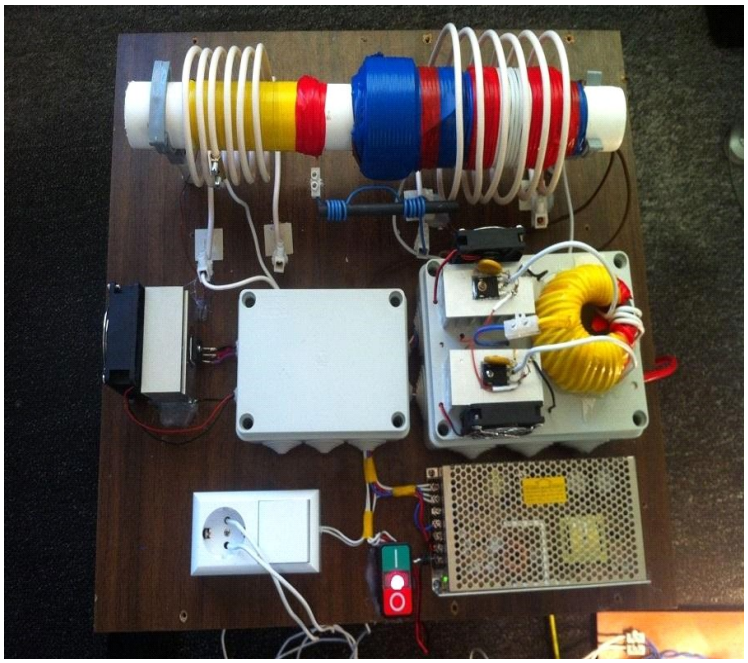
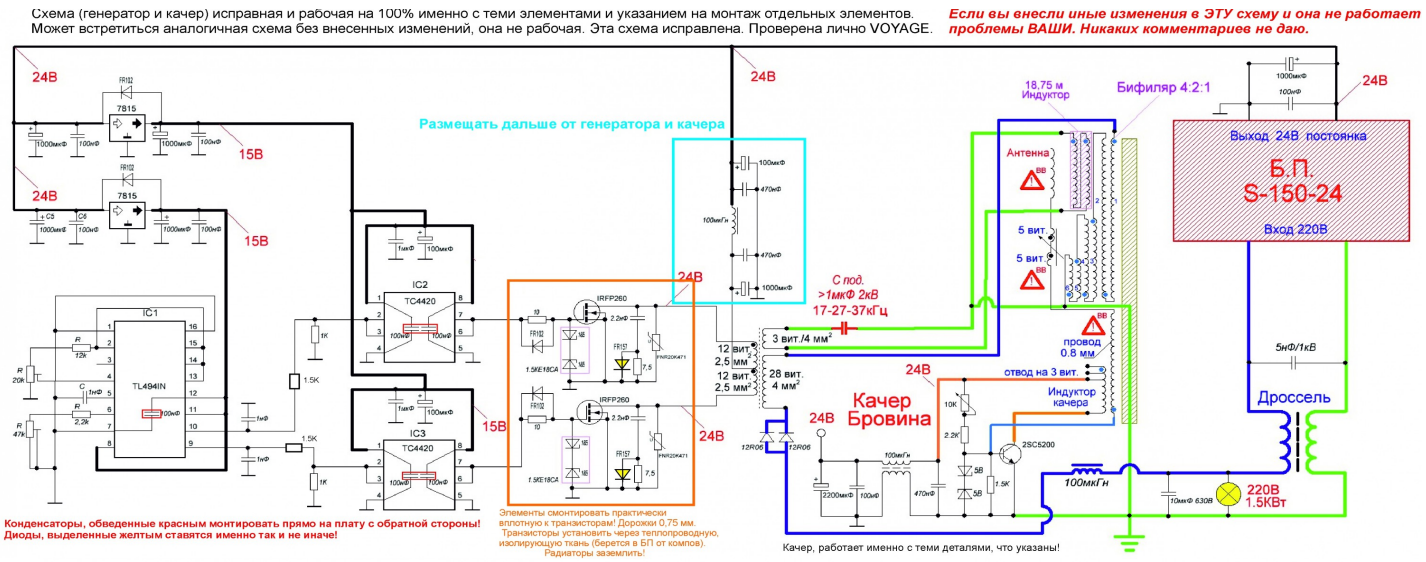
This Project and Document are on going "Works in Progress" and change often...

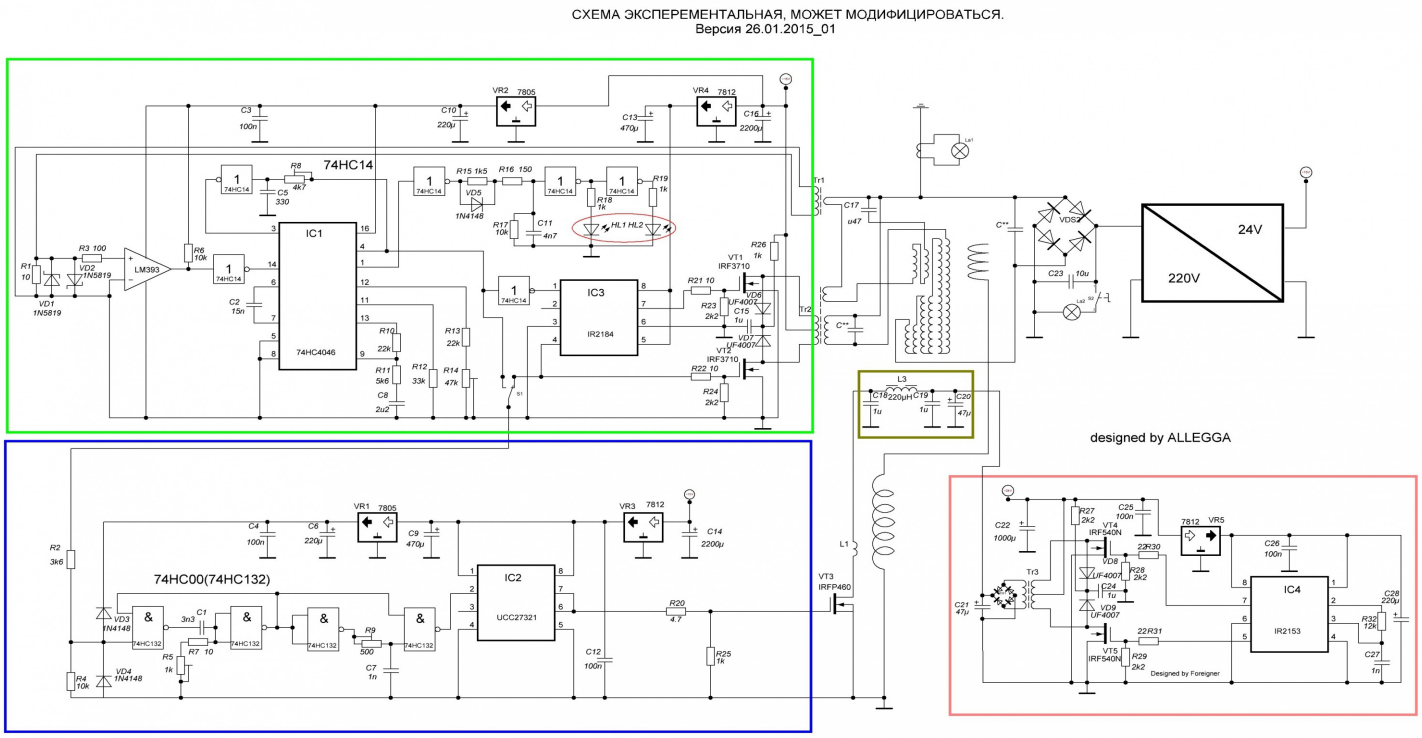
Orig: 12/08/16 Demonstration of the generator @ VTvKD
12/01/16 Generator 4 kilowatta (demonstration in the forest)
Modified: 01/11/17 03/04/17 03/23/18
05/11/21 - add $e=mv^2$ [excess energy source] & (pseudo) Velocity Modulation [HV to roller transfer mech]

Generator 4KW - Demo in Forest - System Analysis



Simplified Schematics





***NOTE*: these schematics may contain inconsistencies and are for reference only!**

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Coils in the installation, Torroid Transformer and "Shnyaga".

There are at least 5 coils in the system. Two for Tesla (Tesla's transformer) - an inductor and a high-voltage Tesla on the coil former, one 6-7 large turns - so called antenna (above the inductor), and two coils on the former, tightly wound one on top of the other - an inductor

in a resonant circuit and a so called remover bifilar also called the grenade coil.

Three more windings are on a large ferromagnetic toroid-magnetic circuit, sometimes called a pot which contains (3-4 turns for the resonant circuit of the inductor, 26-28 turns in the circuit of the bifilar-grenade, and 12 + 12 turns for a push-pull), this is a ferrite ring from an old cathode ray picture tube TV.

And the "shnyaga" on a piece of round ferromagnetic rod with two oppositely wound windings of 5-6 turns each, this connects the Tesla's HV to the so called antenna.

Two generators - Tesla and push-pull

There are two independent generators,

1) A push-pull (or pumping) generator, a standard scheme, push-pull is translated as push-pull (literally push-pull);

2) A Tesla generator - it can also be a controlled kacher , or most likely a second independent and controlled oscillator is used here, with feedback from the resonant circuit, which includes the inductor coil.

The frequencies of both generators are precisely and consistently multiples, this is very important.

Matching and frequency multiplicity of two generators

Push-pool works on video at 15 kHz. The Tesla generator operates at a frequency of 1.5 MHz, it outputs pulses to the Tesla coil (or, most likely, it emits bursts of pulses) - such frequencies are called by Ruslan in this video (he brought an oscilloscope to the forest and adjusted the generator on the spot, but not filmed it). And in all other videos on this type of generator - frequencies are close to these. The frequency multiplicity in this setting is 1 to 100 apparently.

In other types of EE generators, the frequency ratio of the two internal generators can be lower: from 1 to 4, to 1 to 40.

Frequency matching options: a PLL

Maybe he uses a generator frequency divider by Tesla (it is about 1.5 MHz), and after dividing 100 to 1 this new low frequency controls the operation of the push-pull, here the synchronization of the two frequencies is automatic (in the latest settings). Then the PLL is not needed, as Ruslan says in the last videos.

PLL is a phase locked automatic frequency control (tracking and adjustment of frequency and phase between two signals), sometimes it is also just AFC (only for frequency).

Or there are two independent oscillators, but one (for Tesla, high-frequency ~ 1.5 MHz, on one IRFP 460 mosfet) adjusts in frequency and phase, adjusts must be very accurately done - this is important !!! - to the frequency and phase of the low-frequency current fluctuations (~ 15 kHz) in the inductor circuit, since it is a resonant circuit (the first installation options, a PLL is needed). And the frequency of low-frequency oscillations in the inductor is set by the frequency of the push-pool generator. That is, in this version, the Tesla generator is adjusted in frequency (taking into account a constant, fixed multiple of two frequencies) to the push-pool generator.

It is also possible (vice versa): the frequency of the push-pool generator is adjusted to the frequency of the Tesla generator (subject to the frequency ratio of 1 to 100). Because it is advisable to swing the BB Tesla coil with the Tesla generator precisely at its own frequency in order to get the maximum voltage pulses at the output of the BB coil, and so that the BB pulses retain their unipolarity.

<u>There are pros and cons to both options.</u>

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As a result of experiments, and as a result of Ruslan's growing understanding of how the generator works (and also because of different power semiconductors), he has several options for switching on coils and nodes in his coils. And in general, he assembled and brought to the operating mode (i.e. set up before generation) several types of generators, i.e. circuits with different coils.

The processes in the coils **(and in the oscillatory circuits into which these coils enter)** ***are primary in order to obtain an increase in energy*****.**

Electronic components and circuit options are important, but still secondary, this is just a way to achieve the desired modes in the coils, including a way to obtain the necessary short high-voltage unipolar pulses acting on charged particles oscillating in a resonant circuit - from which Excess Energy **(EE)** emerges.

For EE one needs very good, i.e. accurate and stable, synchronism (and in-phase) of external unipolar High Voltage (HV) pulses and current fluctuations in the inductor, stable and accurate maintenance of their frequency multiplicity. The transition to the excitation mode is very narrow in settings, this mode is capricious and sensitive to everything, the EE mode

excitation is very "difficult". All this is said by Ruslan.

It looks like the EE regime can depend on many little things, not all of which Ruslan himself is aware of, or fully understands. Or he sees them in experiments and tuning, but does not talk about "little things" in the videos. For the people to work on their own, so that others have their own experience and their own understanding of the processes in the installation.

In general, you won't be able to set up a self runner on the fly. Ruslan repeats all this many times in his videos.

HV impulses need unipolar, more precisely, as unipolar as possible. And Ruslan obviously uses not one impulse, but a short burst of impulses.

To achieve all this (synchronism, the correctness of the duration of the pulse width and pauses between them, and stability of the entire device), you must at least very carefully filter the noise in the power circuits and in the control circuits, screen and ground the node boards, screen and ground the control wires and power (high-current) wires near the boards, stabilize all voltage supplies as much as possible. You need to carefully install the elements on the boards, use short conductors, you need to fix all the coils, wires from them, loop capacitors well (so that the frequency does not float, you need stability in units of kHz, if not hundreds, tens and even units of hertz). Naturally, everywhere you need to use good elements, with reserves of characteristics. Ruslan constantly talks about this in the videos.

They complain to him that others are failing. And he answers in the sense that ultimately you are to blame yourself, and that you simply do not want to understand the processes on your own, to investigate what is happening in the generator, in the coils. What he knew and did - he told everything. Indeed, Ruslan has already told a lot, in comparison with other authors of working EE generators.

Apparently he himself is used to doing everything neatly and consistently, he is used to working as a professional, and for him it is somewhat wild that many people do everything differently, do it casually, and most importantly, mindlessly. They do not listen to what he says, they whip the gaggle (many repeaters proport their own great experience, hence an elusive self-confidence), and then they complain that it does not work out.

In short, such a conclusion has developed for me at the moment, from watching almost all videos, reviewing comments, reading chat groups of many schemes.?

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<u>After watching videos and sorting information, such a scheme of energy circulation has developed.</u>

From the power source (first the battery, then self-energize the standard 220-240 V / 24 V inverter, which has small air holes over the entire lid), the generator is powered according to the push-pull scheme, it is powerful enough, when powered by 24 V, currents on test lamps-loads of more than 20 A.

From the power source through two keys (switched-mosfets), the push-pool in turn gives out rectangular unipolar current pulses on two arms (two halves of the winding, 12 and 12 turns if the power is 24 V, with a common midpoint), the direction of the current in the arms is opposite (opposite, in turn, first left to the middle, then right to the middle, etc.), the direction of the winding is the same in both halves-shoulders, a tap is simply made from the middle. Due to the opposite currents in the shoulders, the magnetic flux along the pot for half a period is directed in one direction, half a period in the opposite direction. As a result, bipolar current pulses act on the pot and other windings on it, with the voltage swing across the keys equal to plus or minus the supply voltage.

Between the rectangular control voltage pulses from the TL494 microcircuit, it means between the pulses to the mosfet drivers, there are pauses. This is the dead time for the push-pull. The rising and falling edges of rectangular pulses take up part of the time resulting in a kind of bipolar rectangular approximation to a bipolar smooth sinusoid.

Pauses in push-pool are protection of keys (switch-mosfets) from overcurrent, i.e. from short circuit. The currents in the same arms are opposite and equal, so if both keys are on at the same time, then there will be two opposite and equal magnetic fluxes, they will be compensated, the inductive resistance will become almost zero, only an insignificant ohmic resistance of a thick wire in the arms (12 turns) will remain, there will be a short circuit on the keys if there are no protective pauses between pulses.

<u>Operation</u> (reference: Schematics)

Through the ferrite pot, rectangular bipolar current pulses (oscillations) from the push-pool are transmitted simultaneously to a removable circuit (there is a grenade-bifilar coil, one or two capacitors, everything is on ground), and to a resonant circuit (there is an inductor, a capacitor, and everything on ground; there is also a non-contact current sensor for feedback).

Under the action of these current pulses from the push pool, forced oscillations of the electric current arise in both circuits (grenade and resonant inductor).

At the same time, a controlled generator works from the power source to the Tesla coil. The generator delivers precise current pulses to the Tesla inductor, they excite current and voltage pulses in Tesla's high-voltage secondary HV coil. The pulse voltage in the secondary HV coil increases with the distance (number of turns) from the Tesla inductor, at the end of the HV it is of the order of several kilovolts (2-5 kV). The other end of the BB, which is close to Tesla's inductor, is connected to ground. *{In general, for a Tesla coil: ground end is current - open end is high voltage}*

These high-voltage pulses from the end of the Tesla coil, through the filter-regulator "shnyaga", are fed to 6-7 large turns external coil - so called antenna , to one end, the other end is not connected to anything (it hangs in the air).

"Shnyaga" apparently delays the passage of the HV pulse a little, and dampens low-amplitude oscillations near zero (dissipates the energy a little). Moreover, these properties can be slightly regulated: the number of turns, and the distance between the turns and between the opposite windings, the position, dimensions and material (properties) of the ferrite core, and other parameters. This is one of the *"fine tuning"* nodes.

The antenna is located on top of the inductor, below this coil is the bifilar grenade. Both in the inductor and in the bifilar grenade alternating currents flow, i.e. charged particles are moving. Particles are affected by unipolar High Voltage pulses in the antenna. But the inductor is located directly under and inside the antenna, closest to the antenna. And the grenade is (wound) under the inductor, also inside the antenna, but partially shielded from the antenna by the inductor. Therefore, unipolar HV pulses in the antenna act mainly on the current, on particles in the inductor, i.e. to the resonant circuit. And not on a bifilar grenade, i.e. on a removable contour.

There is no galvanic energy pickup in the resonant circuit, no load. Loading and galvanic energy extraction take place in a removable circuit (bifilar grenade).

The resonant circuit is swayed by bipolar rectangular current pulses from the push-pull, through the pot and winding 3-4 turns (as well as the removable circuit, through the pot and winding 26-28 turns). Therefore, forced oscillations occur in the unloaded resonant circuit, where the inductor is connected. These oscillations are also adjusted by selecting the capacitance of the loop capacitor, possibly until the coincidence (or the closest approximation) of the exciting frequency from the push-pool - with the frequency of natural

oscillations of the current and voltage in the resonant circuit, therefore, to the maximum amplitude of oscillations - i.e. before resonance.

Not all schematics, especially earlier ones, show the 26-28 pot core turns connected in series with the grenade coil; some show no 26-28 turns and others only show the 26-28 pot core turns driving the circuits power.

Since, in addition to the approximation of the natural frequency of the circuit (by selecting the capacitance of the loop capacitor) to the driving frequency from the push-pull (~ 15 kHz, and it, in turn, must be accurately and stably tied to the natural frequency of the HV Tesla coil ~ 1.5 MHz, with constant frequency multiplicity of 100 to 1), external unipolar HV pulses from Tesla also strongly affect the resonant circuit - then the amplitude of current oscillations in the resonant circuit reaches 100 amperes. Kulabukhov measured the current, and reports in one of the videos.

To measure the current, and for the PLL circuit, a sensor is used - a current transformer. This is a small ferrite ring with a winding, the ends of the winding are connected to a sufficiently powerful resistor, several kilo-ohms. The ring is put on the wire of the resonant circuit, through which the measured significant and large currents flow. The magnitude and shape of the voltage across the winding of the ring (i.e. on the resistance) is measured by an oscilloscope, or by a PLL circuit.

The ferrite material of the ring can enter a state of saturation at the maximum value of the current in the wire (and therefore in the winding of the ring), while the shape of the voltage pulse on the winding becomes sharp. Apparently, for phase and frequency synchronization (for PLL), a pulse with a sharp shape is desirable, i.e. transition to saturation of ferrite according to the magnetic field strength, i.e. you need a small cross section of the ring and many turns.

To measure current, saturation is not needed, so the number of turns is small, and the ring itself is larger. The magnetic permeability of ferrite naturally affects. The number of turns on this ring in the rollers is different, Ruslan mentioned both 100 turns and 30 turns. In the last videos, the number of turns is small, about 20-30.?

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To get an energy addition (EE), you need to synchronize the oscillations of a large current in the inductor (resonant LC-circuit) and high-voltage voltage pulses on the antenna (or a short burst of these high-voltage pulses) in some clever, yet incomprehensible way. *[See the note below; this remaining mystery has been solved]* Those synchronize sinusoidal currents in the

LC-circuit-inductor - with unipolar current pulses in the Tesla inductor, which create HV voltage pulses on the antenna.

If everything is done correctly, everything is coordinated and tuned correctly - the voltage pulses from Tesla seem to push the charged particles in the inductor, there is an increase in energy, Free Energy (EE) appears. This is shown by the results of Ruslan Kulabukhov. He speaks about these conclusions directly, clearly, and more than once in his videos.

It is clear that not only Kulabukhov has the practice of obtaining EE. For example, the EE is received by Roman Karnoukhov (Shark), Alexander Romanov, Sergey Alekseev, and many other people.

Energy Addition (EE) - only recently discovered (05/11/21) - *independantly*

Excess energy is added through a mechanism of electron velocity (created by HV pulses interacting with the resonant inductor/grenade coil signal wavefront. This HV beam - signal wavefront is Velocity Modulation and is well known in "O Type" Traveling Wave Tube operation. Since the electron (e) velocity is squared in the equation $e=mv^2$, additional power is created in the system. A detailed analysis of Velocity Modulation is beyond the scope here.

When Ruslan explains his understanding of how EE is obtained, he also says that charged particles not only move, but also rotate, and synchronously, consistently, hence sinusoidal oscillations are obtained.

Such a description outwardly somewhat strongly resembles the theory of Alexander Romanov (which only Romanov understands well, apparently, unfortunately).

Namely, according to Romanov: charged particles can stand (i.e. not move along the conductor) and at the same time they can synchronously rotate around their axes stronger or weaker, and can synchronously change the directions of the rotation axes. As a result, energy can be transmitted through the conductor without the movement of charged particles. (Of course, the particles can also move translationally and thus transfer energy - as in a normal electric current).

Romanov also says - to obtain EE, it is necessary to add the current and voltage (apparently, a high current and high voltage are meant).

Further (after pushing the particles in the inductor by impulses from Tesla), part of the energy is removed, but not from the resonant circuit, but from a removable LC circuit (it includes a bifilar grenade coil).

This is done by connecting (i.e. galvanically) a power rectifier bridge on four RF diodes to a capacitor in the circuit, i.e. by rectifying part of the alternating current from the removable circuit (with rectification of the entire voltage in the circuit on the capacitor).

After the diode bridge there is a storage and smoothing capacitor. In one of the versions of the generator, Kulabukhov shows that this is a non-polar capacitor (or 10 µF 630 V, or 12 µF 450 V).

Further, the rectified and smoothed voltage (and current), after the diode bridge and the storage-smoothing capacitor (that is, the part of the energy removed from the removable LC-circuit):

1) partially returns to the standard 220/24 V inverter (power supply), there it is converted downward in voltage (the constant voltage drops from approximately 220 volts DC to stabilized 24 volts DC), and then goes to the unit's self-supply,

2) is partially removed from the unit into the payload (via a socket with a switch), for example, to 500 watt lamps.

In a removable LC-circuit, it seems that not one, but two capacitors C can enter.

For example, one video shows the option of connecting one capacitor C1 in parallel to a small coil-winding on the pot L1, the second capacitor C2 is connected in series with a large grenade coil L2 and winding L1.

That is, the removable circuit includes two coils: a winding of 26-28 turns on a ferrite pot (L1), and a bifilar grenade coil (L2) with a certain total wire length of 38 m and an indefinite number of turns.

In total, there can be up to 4 different options for including 2 coils and 2 capacitors in one closed loop.

One video shows one particular version of the removable circuit described above (C1 parallel to L1, C2 in series with L2 and L1).

Another video shows the inclusion of all 4 elements (C1 L1 C2 L2) in series.

In a later video, Ruslan gives another version of a removable circuit, which includes a grenade coil, a winding of 26-28 turns on a pot, and one capacitor (not two), grounded on one side - they are connected in series. Plus an additional coil-smoothing choke, which is connected between the capacitor (ungrounded terminal) and one input of the rectifier diode bridge, the second input of the bridge is connected to the grounded terminal of the capacitor.

The second, resonant LC_circuit includes two coils: an inductor coil, and a winding of 3-4 turns on the pot, and one capacitor is included. They are connected in series.

The capacitance of the capacitor must be adjusted, it seems, since it is made up of several parallel capacitors.

In all videos about the EE generator (based on the Shark generator) - Kulabukhov recommends counting not the number of turns in the inductor and in the bifilar grenade, but the total length of the wire in the winding of the coils. Namely, the bifilar garnet should have 38 m (a quarter of the wavelength with a frequency of about 1.8 MHz, this frequency was recommended by Karnoukhov from his experiments). In an inductor, the length of the wire should be exactly 2 times less than in a grenade, i.e. 19 m.

Both coils are wound on a standard plastic pipe 50 mm, in some complicated ways (described in detail), Ruslan said about this several times.

The cross-section of the wire in the coils in the very first rollers was 2.5 mm^2 (possibly even 1.5 mm^2), in the last rollers it can be even more (4 mm2), due to the increase in currents and the power of the installation.

In the most recent videos, Ruslan says that winding with a bifilar in a removable grenade is not necessary, and can even be harmful.

<u>Energy circulation</u>

What is interesting about the removable LC-circuit.

It turns out that energy is simultaneously pumped into it from the internal power supply

unit (PSU) - to power the push-pool and its 2 half-windings (shoulders) through 2 keys, then through the magnetic circuit-pot and winding of 26-28 turns, the energy is introduced into the removable LC-circuit ...

At the same time, part of the energy is removed from the removable LC-circuit, through the diode bridge on the loop capacitor of the removable LC-circuit, and then according to the circuit to the power supply and in parallel to the load.

There is a circulation of energy along a closed path (loop):

BP => current pulses through the push-pool keys => push-pool shoulders on the pot => electromagnetic field along the pot => 26-28 winding turns on the pot => grenade coil and removable circuit => diode bridge => PSU.

Due to the tight, close winding of 2 coils, large currents (90-100 A) act on the bifilar grenade coil (removable circuit), flowing through the inductor coil in the resonant LC circuit. Obviously, some of the energy from this resonant LC circuit is transferred through the electromagnetic field to the removable LC circuit.

<u>There is a circulation of energy along a closed path (circuit, branches):</u>

PS => current pulses through the push-pull keys => push-pull shoulders on the pot => electromagnetic field along the pot => 3-4 turns winding on the pot => inductor coil and resonant circuit => electromagnetic field of the inductor coil => grenade coil and removable circuit => diode bridge => power supply unit.

To the energy of current oscillations in the resonant LC-circuit, some part of the energy of high voltage pulses is added at the hot end of the BB coil of the Tesla transformer, through the shnyaga and the antenna.

There is a circulation of energy along a closed path (loop):

BP => current pulses through the Tesla key => Tesla inductor => the electromagnetic field of the Tesla inductor => Tesla's explosives => shnyaga => antenna => magnetic and electrical energy of explosive voltage pulses on the antenna => coil-inductor and resonant circuit => electromagnetic field of the coil-inductor => coil-grenade and removable circuit => diode bridge => PSU.

The scheme of energy movement in the installation can also be described as follows.

One common power source-converter provides energy for operation of two generators - Tesla generator and push-pool generator. (Energy from the source is divided into 2 streams)

The push-pool pumps energy into two LC circuits - resonant and removable, and these circuits constantly interact and transfer energy between themselves (specifically, it is transferred from the resonant circuit to the removable circuit). (The energy from the push-pool is divided into 2 streams)

The Tesla generator pumps with energy the oscillations in the HV coil (and then pumps the HV vibrations on the antenna through the shnyagu). The antenna transfers the energy of these explosive vibrations to the resonant LC circuit ("Tesla's impulses push the current in the inductor" - says Kulabukhov).

That is, the current oscillations in the resonant circuit are pumped simultaneously by 2 sources: the push-pool generator directly, and the Tesla generator, as it were, not directly, but through high-voltage voltage pulses in the BB coil and antenna. (In a resonant circuit, two streams of energy are combined into one.)

Also, current fluctuations in the removable circuit are pumped simultaneously by 2 sources: a push-pool generator directly, and large current fluctuations in a closely wound resonant circuit. (In a removable circuit, two streams of energy are combined into one.)

Part of the energy of current oscillations in the removable circuit is removed through a loop capacitor and a diode bridge (i.e., not all of the oscillation energy in the removable circuit is removed). (The energy flow in the removable loop is divided into two flows, one flow still oscillates, circulates inside the loop, the second flow is removed from the loop.)

This withdrawn-removed energy is divided into 2 parallel streams. In part, it returns to the power source-converter (PSU) common to all nodes of the device, so that after being converted into a PSU, it will close the energy circulation in a closed circle inside the installation (self-feeding).

The rest of the removed energy is transferred to a useful external load.

These are the interesting 3 circuits (closed paths) of energy circulation.?

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<u>Two independent generators.</u>

The case of floating high frequency, and frequency multiplicity

In this setup, the frequency of the Tesla generator is approximately 100 times the frequency of the push-pool generator (approximately 1.5 MHz and 15 kHz). Therefore, a change (drift) of Tesla's frequency, say by 0.1% (relative units), or by 1.5 kHz in absolute units - corresponds for a push-pool to 100 times greater relative frequency change. For example, changing the Tesla frequency (initially 1500 kHz) to an absolute 1.5 kHz - a relatively high Tesla frequency is 0.1%, a relatively low push-pool frequency (15 kHz) is 10% (1.5 kHz and 15 kHz).

The ratio of frequency drift by 0.1% and by 10% (1: 100), relative to the natural frequencies of the two systems, with a change in the high natural frequency - is true if two oscillating systems (BB + shnyaga + antenna, and a resonant LC circuit) - are independent (they can independently change their own frequencies), and two generators, each pumping energy into its own system, work independently of each other. Moreover, both generators (push-pool and Tesla) independently of each other can pump their systems with energy at the natural (resonant) frequency of these systems, i.e. optimal.

One generator is independent, the other depends on it

The frequency of the push-pull pumping can be rigidly tied to the frequency of the Tesla generator, by dividing the frequency of the Tesla generator by the required fixed number of times (for example, 100 times). That is, of two independent generators, leave only one generator (Tesla) independent, and tie the second generator (push-pull) in frequency (and phase) to the first generator.

You can *pre-tune* in resonance, by selecting the capacitance of the capacitors, those LC-circuits that are tuned to the driving frequency of the push-pull (most likely this is a resonant LC circuit, an inductor, and possibly tuned to resonance and a removable LC circuit).

The frequency of the generator to the Tesla inductor can change, drift away from the initial value, let's say very slightly - by 0.1%, or 1.5 kHz.

For example, if the Tesla generator itself is not sufficiently stabilized, and does not have

feedback from the system of coils that it pumps (what happens to the natural frequency of the system of 3 coils - in this case it does not matter). Or if the Tesla generator automatically adjusts to this natural frequency (there is feedback), and the natural frequency of the "Tesla's BB + shnyaga + antenna" coil system has changed for some reason (lets say by the same 0.1%).

Then the frequency of the push-pool generator will also change, due to its tight binding to the frequency of the Tesla generator.

Suppose Tesla had a frequency of 1500 kHz, and the frequency became 1501.5 kHz (Tesla's frequency dropped by 0.1% or 1.5 kHz). After dividing the frequency by exactly 100 times, the push-pool frequency was 15 kHz, it became 15.015 kHz, that is, relative to the original 15 kHz, the push-pool frequency also increased by 0.1% or by 0.015 kHz.

Again.

No division of frequency. Let's say at the beginning it was 1500 kHz and 15 kHz, the frequency ratio is exactly 100.00 = 1500/15. It became 1501.5 kHz and the same 15 kHz, frequency multiplicity 1501.5 / 15 = 100.1.

With frequency division. In the beginning there were 1500 kHz and 15 kHz and a frequency of 100.00. It became 1501.5 kHz and 15.015 kHz, the multiplicity due to division remained at 100.00.

But it was preserved at the cost of increasing the push-pool frequency by the same 0.1%, due to the unnecessary departure of the push-pool from the natural (resonant) frequency of its system (resonant LC-circuit), without the need for this (we assume that the natural frequency of the push-pool system has not changed).

The frequency multiplicity is preserved. But there is an unnecessary drift of the frequency of the push-pool generator - when the frequency of the Tesla generator drifts.

What does the Tesla generator adjust to?

The Tesla generator should automatically adjust to the natural frequency of the "BB coil + shnyaga + antenna" system, with any changes in the geometry and in the surrounding space. That is, there must be a natural frequency feedback.

Frequency matching takes place automatically in the card. Moreover, in fact, without any regulation of the phase shift (between the current in the Tesla inductor and the voltage at

the output of the BB coil) - if there are no regulating elements in the circuit for connecting the cold end of the BB to the base of the transistor.

There must be an accurate and stable regulation of the duration of a unipolar current pulse through the Tesla inductor (i.e. regulation of the duty cycle), in order to obtain the maximum possible unipolarity of the voltage pulse at the output of the HV Tesla coil. A voltage pulse at the output of the explosive is obtained in response to a current pulse through the Tesla inductor.

What the push-pool generator adapts to?

The push-pool generator on one side must be exactly multiples in frequency and phase with the Tesla generator - to get EE. On the other hand, the push-pool must be precisely tuned to the natural frequency of the resonant LC-circuit, which includes the inductor coil and the selected (tuned) capacitor of the circuit - to pump the maximum current and voltage in the circuit (to obtain resonance), therefore to increase EE.

A variant of matching generators with frequency division and adjustment of the division multiplicity

Tesla's natural frequency (Tesla's explosive + shnyaga + antenna), and the resonant circuit's natural frequency can change, deviate from the frequencies at the initial tuning of the generators, and these 2 frequency drifts occur independently.

If the frequency of the Tesla generator is divided, then the frequency multiplicity and in-phase of the push-pool generator in relation to the Tesla generator is performed automatically. It is possible to adjust the phase shift if it is relevant for EE. (The exact position of the beginning of a long period of low frequency oscillation, within any one short period of high frequency oscillation, in a series of identical high frequency oscillations during one period of low frequency oscillation.)

If the frequency division ratio can be automatically changed (within small limits, for example, in steps of 1 or 2), to keep the push-pool frequency as close as possible to the natural frequency of the resonant circuit, then two generators are simultaneously adjusted to two natural frequencies of two independent resonant systems. For Tesla's generator exactly, for a push-pool generator approximately.

Apparently, the fact that the generator hits the natural frequency of "Tesla's explosives + shnyaga + antenna" is more important for obtaining EE.

<u>The natural frequency of the HV coil</u>

The natural frequency of the HV coil of the Tesla transformer is determined by the parameters of the HV coil:

1) wire diameter

2) frame diameter

3) number of turns i.e. the height of the winding of the BB coil

4) the step of winding the wire on the frame (the gap between the turns).

Thus: the natural frequency of the HV coil is largely determined by the total length of the winding wire. The shorter the total wire length, the higher the natural frequency of the coil, and vice versa.

The diameter of the winding affects - the larger it is, the greater the total inductance, and the lower the natural frequency.

We assume that the explosive coil is wound in one layer in one direction on a cylindrical frame. The frame is a plastic pipe with an outer diameter of 50 mm.

Distributed capacitance and inductance, total inductance

Distributed and total inductance (and distributed capacitance) increases, and the natural frequency of the coil decreases with: 1) an increase in the frame diameter; 2) an increase in the number of turns, i.e. winding height 3) a decrease in the diameter of the wire, this will actually happen due to an increase in the number of turns at the same winding height.

The BB wire of the coil can be wound not close to the loop, but with a constant gap (for example, two identical or different wires, then the second wire is removed). To increase the operating voltage between turns, to increase the distributed capacitance, and to reduce the distributed and total inductance. That is, to increase the natural frequency of the coil.

In the case of winding a wire with a gap, the natural frequency of the coil will depend on the size of the gap, of course.

Natural frequency of the HV coil plus other elements

Since the BB coil is connected to the antenna coil through the "shnyaga", the same distributed inductances and capacities of the "shnyaga" and antenna are added to its distributed inductance and capacitance. As a result, the distributed capacitance and inductance of the entire system becomes larger, and the natural frequency of the "BB coil + shnyaga + antenna" system becomes noticeably lower.

This is exactly what Ruslan showed in one of the videos, when a kacher circuit is used as a Tesla generator.

Kacher in Tesla's transformer

As you know, the kacher on two coils of the Tesla transformer automatically adjusts exactly to the natural frequency of the BB coil (not to the natural frequency of the Tesla inductor), which is in the base circuit, and controls the operation of the bipolar transistor (the inductor is in the collector's power circuit).

In the HV coil, powerful current and voltage fluctuations occur at its natural frequency. At this natural frequency of the HV coil - the transistor in the kakara produces unipolar current pulses, through the emitter-collector to the collector coil (to the Tesla inductor), and is phase-matched. These current pulses through the inductor are the oscillations in the HV coil and are maintained (energy input from the power source), and it is at the natural frequency of the base coil of the Kacher, i.e. BB Tesla coils.

Kacher in general

But in principle, it is possible to work the kacher at the natural frequency of the collector (power) coil, if there are sufficiently strong oscillations in it (for example, it is included in the LC circuit), and the basic (control) coil of the kacher in this mode simply acts as a feedback. In this case, the cacher will automatically adjust the power pulses of the current through the collector to this natural frequency of the coil in the collector circuit (through the feedback on the base, control coil), that is, it will add energy to the collector coil (LC-circuit) to compensate for energy losses in her.

In any case, the power pulses of current through the emitter-collector of the bipolar transistor will be unipolar (the np-junctions of the transistor conduct a large current only in one direction), and from the plus to the minus of the power supply.?

=

Apparently, presumably - it is important that the shape of the current in the resonant circuit is as close as possible to a sinusoid. Despite the rectangular shape of the forcing pulses from the push-pull (which worsens the sinusoidality). Taking into account the relatively small emf induced by the push-pull through the ferrite core of the pot in the winding, there are 3-4

turns on the pot.

That is, the relatively small energy transferred by the push-pool to the circuit for buildup does not greatly impair the sinusoidality of the LC-circuit oscillations.

In the circuits of other Kulabukhov generators, the resonant circuit does not swing directly from the push-pool through a small additional winding (3-4 turns), as shown in the circuit options, in the videos for this generator, it seems.

(RE: The Question of How the Energy Transfers and it's Sources)

-- This important aspect is Addressed Above --

According to Romanov's sound ideas, when oscillating at a natural frequency (resonance), charged particles simultaneously rotating and moving in a conductor have the best, maximally coordinated directions of the axes of rotation (the directions of movement are always coordinated in an electric current), and coordinated speeds of rotation and displacement - precisely in the mode free resonant oscillations in the LC-circuit. Presumably.

Note: Romanov alludes to the process of Velocity Modulation but offers no references.

Perhaps due to this strong consistency - external high-voltage voltage pulses can add their energy to moving charged particles, and disproportionately more in comparison with the energy of the HV pulses themselves. More precisely, disproportionately more than the energy of unipolar current pulses in the Tesla inductor - the cause of the occurrence of high voltage pulses.

These unipolar current pulses in the Tesla inductor receive energy from the power source through the Tesla generator key (it closes-opens). Current pulses in Tesla's inductor create an alternating electromagnetic field around the HV coil, the field excites current and voltage oscillations in the HV.

The range of sinusoidal voltage fluctuations along the HV coil increases towards the hot end, the range of current fluctuations decreases. At the hot end of the explosive, the current is small, but still there is current, because a conductor where this small alternating current can flow is available, this is a shnyaga and an antenna. A small current flows through the shnyaga and the antenna, the current is zero only at the hanging end of the antenna (wire break).

At the hot end of the explosive, the swing of the bipolar sinusoidal voltage fluctuations is

maximal (the current is minimal).

Further, these high voltage pulses go through the shnyaga (2 oppositely wound coils with a small number of turns, on a ferrite core with a diameter of ~ 8 mm, in fact it is a counter and spaced bifilar, after tuning, in most cases, asymmetric in the number of turns). Here they are shifted by some angle in phase (*possibly delayed due to the presence of ferrite*).

Further, the voltage of the pulses appears (acts) on the antenna, which also works as one of the two, the outer plate of the cylindrical capacitor (very rare, not solid). The other, the inner lining of the cylindrical capacitor is the wire of the inductor coil (mainly), since it is closest to the antenna.

This capacitor is cyclically recharged with an alternating high-voltage voltage from the hot end of the explosive, therefore, there is an alternating electromagnetic field inside the capacitor and, accordingly, energy flows between the plates.

Apparently a small alternating current in the antenna also creates its own field and energy flows.

The energy of these bipolar high-voltage voltage pulses on the antenna is capable of increasing the current in the inductor coil, apparently, and hence increasing the vibration energy in the resonant circuit. Moreover, to increase the energy of current oscillations in the resonant circuit is disproportionately larger, stronger, compared to the energy of current pulses in the Tesla inductor, which is used to drive Tesla's transformer. By a mechanism that is not yet understood. Presumably.

Energy increase => $e=mv^2$, transfer => velocity modulation.

On the oscillograms of the voltage at the hot end of the explosive (the oscilloscope probe hangs in the air near the explosive), which Kulabukhov shows in the rollers - it can be seen that the swing (amplitude) of high-voltage voltage fluctuations on the explosive, after turning on the Tesla generator (supplying current pulses to the Tesla inductor) - does not set at a high constant level immediately. And only after about 5-7 high voltage sinusoidal oscillations on Tesla's VVs, growing in swing. The amplitude of oscillations on the explosive increases rapidly from some initial (small) level to a constant, significantly higher level, during these first 5-7 oscillations of the voltage on the explosive, after turning on the Tesla generator.

(This delayed wave growth at the output is also observed in a typical TWT startup.)

This can be seen on the oscilloscope in several of Ruslan's videos (and of course not only for him).

Apparently, during this buildup of high-voltage oscillations on Tesla's explosives (up to 5-6 kilovolts, the words of Kulabukhov, for about 5-7 oscillations - see oscillogram), after switching on the current pulses to the Tesla inductor, a gradual (and fast) swinging of the medium (ether) around Tesla's explosives. Until dynamic equilibrium is established at a certain level. (Above about +5KV positive polarity, in air, a risk of sparking is present, negative polarity threshold is near -15kV)

Perhaps it is the high rate of voltage change (from -5 kV to +5 kV, for half a Tesla oscillation period) that causes this strong, noticeable interaction of the explosive coil with the environment.

We consider: let the Tesla frequency 1.5 MHz = 1.5 * 10 ^ 6 oscillations in 1 second, then the duration of one oscillation period T = 1 / (1.5 * 10 ^ 6) = 0.667 * 10 ^ -6 seconds, and half period = 0.333 * 10 ^ -6 seconds = delta t.

For half a period of oscillations, the voltage at the hot end of the explosive changes from -5 * 10 ^ 3 volts to + 5 * 10 ^ 3 volts, or by 10 ^ 4 volts = delta U.

Then the rate of voltage change in time can be estimated here as delta U / delta t = 10 ^ 4 volts / 0.333 * 10 ^ -6 seconds = 3 * 10 ^ 10 volts per second (30 billion volts in 1 second). (10 ^ x - means ten to the power of x)

This is a very high rate of rise and fall of the alternating voltage in a given place in space and environment. Perhaps that is why Tesla's explosive at the hot end can quite noticeably affect the environment around it, interact strongly with it (as if pushing-capturing the medium more significantly, together with the oscillatory movements of electrons along the explosive wire). High-voltage rapid voltage fluctuations at the hot end of the explosive - you can swing some invisible fluctuations in the medium, it seems.

And perhaps due to these vibrations in the medium (near the hot end of the explosive, and next to the antenna and shnyaga) - you can get some additional, over-unit energy from these vibrations of the medium, vibrations of its elements. (*Energy increase => $e=mv^2$)*

It is clear that a high voltage in itself more polarizes the medium than a low voltage (it displaces the elements of the medium more from equilibrium, as if creating a greater internal stress in the medium - in a given place). With a fast (energetic) buildup of the

medium with a high alternating voltage, the medium passes into forced oscillations with the same frequency as the source of disturbances in the medium, and with the amplitude of oscillations that decreases with distance from the source according to some law.

It is possible that the total energy of these oscillations of the elements of the medium (decaying with distance from the source) is such that, as a result, it is possible to remove energy from the oscillations of an infinite medium, as it were, more than the sum of energy spent on oscillations of a small source of disturbances. If you do everything correctly, if it is correct (for example, in a certain resonance, in a certain mode, in a certain type of energy) and disturb the environment, and remove the energy of the vibrations of the environment (for example, in another form of energy). All this is supposed to be natural.

Tesla's transformer (more precisely, its BB coil) swings in a resonant mode, that is, the driving frequency (current pulses through the inductor and Tesla's key) is equal to the frequency of natural oscillations of current and voltage in the BB Tesla coil, grounded at one end and having the other end hanging in the air (more precisely, the antenna, and not the explosive, has the end of the wire hanging in the air, not connected to anything).

That is, a standing wave appears in Tesla's explosives, which just has its own oscillation frequency (wave resonance frequency). At this frequency, the amplitude of oscillations in the standing wave on the VV is maximum, which can be seen experimentally when excitation is applied to the explosive from a oscillating (variable) frequency generator (preferably sine), and the measurement-tracking of the dependence of the amplitude on the explosive on the generator frequency.

The kacher circuit, for example, easily and quickly adjusts the driving frequency of the current pulses in the inductor to this frequency.

A standing wave is the result of the addition of incident and reflected waves having one common frequency and a constant phase shift between themselves. The incident waves of current and voltage are generated by unipolar current pulses in the Tesla inductor, and apparently go from the section (zone) of the explosive under the inductor to the hot end of Tesla. Reflected current and voltage waves are obtained from incident waves, due to the reflection of current waves (and therefore voltage waves interconnected with current waves) from the hot (hanging, open) end of the antenna (or explosive, if there is no antenna).

In the generator, a rarefied, rare Tesla coil is not in the middle of the explosive, but on the

edge of the explosive coil, and on the grounded edge.

Apparently, more precisely, a unipolar current pulse in a Tesla inductor generates a current pulse in the zone (section) of the explosive under the inductor, which could diverge in both directions. But on one side, the explosive is grounded, and part of the current pulse in the explosive goes through the grounding cable to the ground. This is what Kulabukhov is talking about. (Earth is a very, very large capacitance, therefore having a constant potential, to which the ground cable is connected through a noticeable ohmic resistance of the ground around the ground).

Another part of the current pulse in the explosive goes from the cold to the hot end of the explosive, and then everything is as described. Presumably.

In addition to the distortions of the sinusoid of the current in the resonant circuit, due to the rectangular shape of the pulses from the push pool, the waveform of the current (and voltage) is also distorted by short high-voltage bipolar voltage pulses from Tesla's explosives, which come to the antenna through the shnyaga. That is, an ideal sinusoid of current and voltage in this LC-circuit will not be obtained, and perhaps this is not necessary. Because regardless of the degree of distortion of the sinusoid of the current in the circuit, these explosive pulses give an increase in the energy of the current oscillations in the resonant circuit.

[1.3 of 4] (restored 1 month after deleting this comment, possibly by the channel's author)

<u>Push-pool pumping of oscillations in the resonant and removable circuit</u>

Forced current oscillations in the inductor coil (in the resonant LC circuit) are excited (pumped) by bipolar rectangular current pulses from a two-arm push-pool generator (two IRFP 260 mosfet keys) through a transformer on a ferromagnetic pot, through two push-pool arms in the form of 12 + 12 turns (if the power is 24 V), and if the power is 12 V then there are 6 + 6 turns in the arms. Both shoulders are wound on the pot in one direction, i.e. from one winding on the pot 24 turns (if the power supply is 24 volts), a tap is simply made in the middle, and this forms two identical halves of the winding (shoulders).

The pumping energy in the form of current pulses from the power source through the keys,

in turn, from the arms of the push-pool is transmitted through the pot-magnetic circuit to the 3-4 turns winding connected in series with the inductor to the resonant LC-circuit, the circuit also includes a capacitor.

At the same time, current pulses from the push-pull winding are transmitted to the winding of 26-28 turns in a removable LC-circuit, which also includes a bifilar coil (grenade) and a capacitor (or 2 capacitors). That is, the push-pool simultaneously pumps (pumps up energy) the second, removable LC-circuit.

In this EE generator, 1 push-pool through 1 transformer (on a ferrite pot) pumps energy both LC-circuits synchronously, in one phase, without a phase shift between the pumping of the resonant circuit by the push-pool and the removable circuit.

If you pump not 1, but 2 push-pools, each with its own transformer - i.e. one to the resonant circuit, the other to a removable circuit, then you can adjust the phase shift between 2 pumps, which means between the phases of 2 oscillations in 2 circuits. You can adjust the amplitudes and fillings of 2 pumping with rectangular current pulses, which means to influence the amplitudes of 2 oscillations in 2 circuits. Both pumping by current pulses still create counter-alternating magnetic fluxes along 2m ferrite magnetic circuits (they constantly remagnetize the ferrites). By changing the phase shift and the ratio of the amplitudes of current fluctuations in two interacting LC circuits, it is possible to influence the modes of exchange (transfer) of energy between the circuits.

<u>Push-pool and PLL semiconductors</u>

The push-pool control chip is a standard TL494. Two field-effect transistors-mosfets (two push-pool keys) are of the IRFP260 type, they are switched on / off via the TC4421 type mosfet drivers (maximum current up to 9 A). Ruslan talks about all this in his videos. (Carefully review the semiconductor specification sheets - not all devices meet the frequency or other requirements)

Adjustment of the push-pool generator in frequency and phase (PLL - if any), to maintain the maximum peak-to-peak current fluctuations (resonance) in the resonant LC-circuit (inductor) - is made on a standard CD4046 microcircuit (Phase Locked Loop = PLL).

<u>Carrier and bursts of pulses in the Tesla generator</u>

It is also possible that a second TL494 is sometimes used in a Tesla generator to generate bursts of pulses (low frequency rectangular envelope for a high frequency carrier), depending on the version of this generator circuit. Those create controlled rectangular low-

frequency modulation in amplitude (from zero to maximum), a high frequency carrier (or simply carrier) from a Tesla generator.

The carrier is a sequence of high-frequency (~ 1.5 MHz) rectangular unipolar current pulses through the key mosfet of the Tesla generator. It is highly desirable that the carrier be exactly at the natural (resonant) frequency of the system of 3 coils: Tesla's BB on ground + shnyaga + antenna.

The degree, the fraction of filling the current pulse of each period of the carrier (duty cycle parameter), i.e. the ratio "pulse duration / period duration" is adjustable ("period duration = pulse duration + zero pause duration"). Sometimes this parameter is also called the duty cycle.

<u>The duty cycle must be stable.</u>

The selection of the duty cycle of the carrier is important to obtain the maximum unipolarity of Tesla's explosive pulses.

ICs 74HC00 and 74HC14 in the carrier high frequency generator

It is very likely that Kulabukhov also uses chips 74HC00 (4 gates of NAND, each with 2 inputs and 1 output), or 74HC14 (6 Schmitt triggers with inversion at the output of NOT, each with 1 input and 1 output).

Both on NAND elements and on Schmitt triggers with inversion at the NOT output - you can assemble rectangular unipolar pulse generators (i.e., carrier generators, the device needs a frequency of up to 2 MHz) if you add feedback circuits with capacitors and resistors, and add if necessary other elements (for example fast diodes) - i.e. if you create a binding for these 74HC00 and 74HC14 microcircuits.

<u>There are a lot of working circuits of such generators.</u>

By adjusting the parameters of the RC circuit elements (resistance, capacitance), especially in the feedback circuit, you can change the frequency of generation of rectangular pulses, and the degree of filling in the sequence of pulses (duty cycle).

The 74HCxx series of microcircuits is relatively fast (the time for switching a logical state between zero and one is of the order of 3-4 nanoseconds). Therefore, the leading and trailing edges of rectangular unipolar pulses on these elements are quite steep.

<u>Other elements in the circuit</u>

Ruslan constantly uses voltage stabilizers 5 V and 12 V on the power rails, to power the microcircuits, mosfet drivers, and all circuit nodes in general.

He also constantly uses smoothing (filtering) capacitors (non-polar relatively small capacity, and polar electrolytic large capacity) in power circuits. It uses filter circuits such as LC, CR, just chokes-inductors L in the supply circuits, and, possibly, in the control circuits.

Semiconductors of Tesla's generator and rectifier bridge

At first, Ruslan's bipolar transistor npn Toshiba 2SC5200 worked in the Tesla inductor, in a kacher circuit.

Then, in the generator, a field-effect transistor-mosfet IRFP460 worked on the Tesla inductor, which was switched on and off through the TC4421 mosfet driver (maximum pulse current up to 9 A), first in the kacher circuit, then in the generator.

Then Ruslan uses a more suitable 2SK1162 mosfet, with a TC4451 driver (up to 13 A), in the Tesla generator as a key to the Tesla inductor.

A similar situation is for power RF diodes in the output rectifier diode bridge. Different diodes were called: STTH12R06DI, MUR860, other types are also possible.

Mosfet drivers

Powerful high-current mosfets have a rather large input capacitance (gate-source) of the order of several nanofarads (1-2 ... up to 8 nF). See datasheets of different mosfets.

To fully open the mosfet (reduce the source-drain resistance to hundredths of an ohm - see the mosfet datasheet), you need to raise the gate-source voltage to approximately 10-15 volts (it differs for different mosfets). That is, it is necessary to charge a certain capacitor at the input of the mosfet to this voltage. You need to transfer a certain electric charge to the gate, create a current that charges the input capacitor of the mosfet. To do this quickly (in nanoseconds), you need a sufficiently large current, several amperes, or more than a dozen amperes.

This operation - very fast charging and discharging of the input capacitor of a powerful mosfet - is performed well by the specialized drivers of the mosfets, they were created just for this. The driver can be controlled by a voltage of +5 volts (and a small current) from the logic control circuit (commands to turn on / off the current to the mosfet gate and charge-discharge the input capacitor, i.e. open-close the mosfet), can have a separate power supply up to +18+ 20 volts, and a sufficiently large capacitor in parallel with this power supply - it is

these capacitors that charge and discharge the input capacitor of the mosfet through the driver.

All the details, and a typical scheme for enabling a specific driver - see datasheets for mosfet drivers.

Fast (2-3 tens of nanoseconds) switching on / off the mosfet creates steep leading and trailing edges in current pulses through the mosfet from the power source.

<u>The steepness of the edges in the current pulses</u>

The steepness of the edges in the current pulse is the first derivative di / dt of the function (graph) of the current i from time, and the conduction current (not the displacement current).

According to Maxwell's equations, this first time derivative d / dt (the rate of change of something in time, in this case the conduction current) is from the diff. the equations are proportional in explicit form - d / dt from the rotor of the magnetic field strength H (rot H) and the steepness (d / dt) of the displacement current, and indirectly (through another conjugate differential equation in the system of Maxwell's differential equations) is proportional to d / dt from the rotor of the vortex electric field strength E (rot E).

That is, the steepness of the displacement current in the ether, and all the rates of change of electric and magnetic fields: in time (d / dt) and in space (curl) are proportional to it, the slope of the current in pulses.

That is, all transient and periodic in time electromagnetic phenomena - in the device occur somewhat faster and with a large amplitude (swing) - if this steepness of the edges in the current pulses is greater.

<u>Kulabukhov and progress</u>

Ruslan does not stand still, but works continuously, examines the processes in the coils, changes the nodes of the general scheme and tries what happens. That is, he is constantly experimenting. And at the same time, he filmed earlier, and is now regularly filming another video.?

<u>This Project and Document are on going "Works in Progress" and change often...</u>